A Report of Research on an Automated Beamhouse
and
the Computer Modeling of a Tannery

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This report describes two of the leather research programs currently being conducted at the Eastern Regional Research Center in Philadelphia. The first program is concerned with the development of an automated beamhouse. The objective of this work is to unhair, flesh and split brined hides using a continuous conveyer system requiring a minimum of labor. This work, conducted by the Engineering Science Laboratory at the Center, is in an early stage of development and will not be described in great depth. The two principal investigators responsible for this research are Mr. Wolfgang Heiland, the mehanical engineer in charge of design and development of all equipment, and Mr. Michael Komanowsky, chemical engineer in charge of the chemical processes and the operation of the line. The second part of the report is on the development of a computer model of the process which converts raw hides into split and shaved blue crust leather. This model is one development of a cooperative research agreement between Oklahoma State University and the Hides and Leather Laboratory in Philadelphia. The original objective of this project was to construct a model which could predict physical

properties of leather from the chemical treatments performed on the raw hide. We are still a long way from developing such a predictive model. However, as one step on the way to achieving this objective, a rapid and flexible tool has been developed which can perform cost analysis of alternative wet processing systems. In one sense this model is complete in that we have a workable system up to the production of blue crust. This is the model which will be described. It appears now that it will be worthwhile to continue the model to include finished leather and we are making plans to do so.

Automated Beamhouse

The automated beamhouse process has been under development at the Eastern Regional Research Center for several years. The primary objective is to develop and construct a pilot plant which could automatically process a brine cured hide through unhairing, fleshing and splitting with a maximum use of automation and a minimum use of chemicals and manpower.

The development of this process has taken place in a number of distinct phases. The first phase was the construction of a splitting machine which would be capable of automatically feeding an unhaired hide into the splitter to achieve a uniform top grain split. The second phase was to develop a rapid chemical unhairing system based on alkaline sulfide treatment and the third to construct a conveyor system to move the hides through the chemical treatment solutions to unhair the hide, convey the hide through a mechanical unhairing machine, then through a fleshing machine and finally to the automated splitter.

At the current time, the automated splitter and a hide conveyor system have been constructed. The first few hides were run through the chemical unhairing procedure in the pilot plant early in 1982. We are pleased with the initial runs but there will be additional testing and modification which need to be performed before the process is ready for complete disclosure. It is hoped

Nevertheless, the system will be described as developed up to now with the caution that additional modifications will undoubtedly be made as development of the system continues.

The automated splitter was constructed from a standard horizontal splitter rotated 90° on its side so that the hide would enter the feed mechanism from above.

This was of course to take advantage of gravity to help feed the hide into the knife. Various other small modifications to the original splitter were also necessary. The most important step in the development of the automated splitter was the development of a feeding mechanism to mechanically move the hide into the knife to obtain a uniform split (Figure 1).

This mechanism in combination with spreader rolls above the splitter keep the hide in place.

The conveyor system was constructed from new materials however rebuilt tannery equipment was used for unhairing and fleshing. Figure 1 shows the constructed pilot plant at the Eastern Regional Research Center. The construction schematic, Figure 2, shows how the hides move through the chemical process section.

Two men are required to operate the the automated beamhouse. The first step is to lay the incoming brined hides flat on a conveyor belt. The conveyor then moves the hide forward and over a bar on the chain and sprocket conveyor. At this stage, the hide moves past a set of spray nozzles which use the 10% brine bath overflow to remove loose safety salt and debris on the hide. The hide is clamped to the bar on either side to prevent it from floating off in the chemical treatment baths which follow.

As seen in the schematic the hides pass through three baths. The feed rate through the system is two hides a minute. Each bath is sized to allow the

hides to be submerged for the appropriate length of time. There is, of course, additional time required for the hides to move between baths.

These three baths constitute the hair removal process used in the automated beamhouse. The first contains a ten percent salt solution. This solution dissolves any solid salt which was not removed by the spray and loosens additional debris still on the hide. In addition, salt dissolved in the moisture near the surface of the hide starts to diffuse into the bath. The hide then moves into the second bath containing a solution of three percent salt. While in this solution, the salt concentration on the surface of the hide would be reduced but the interior of the hide is likely to be changed very little in this period of time.

It has been demonstrated that salt concentrations in excess of ten percent interfere with sulfide hair removal. This second bath reduces the salt concentration on the surface to eliminate this interference.

The third stage contains a 10% solution of commercial grade sodium sulfide and will ultimately contain 10% salt as salt is picked up during the operation. As hides come into the first bath, the additional salt dissolved from the hides would tend to increase in concentration. As a consequence the solution must be diluted. This is done as needed by feeding back the low salt concentration solution from the second bath. This second bath would also tend to increase its salt concentration due to the incoming hides. Fresh water must be added to this bath to maintain the concentration at three percent salt. The overflow from this bath being used to dilute the first. The third bath containing the sulfide solution will undoubtedly require periodic sulfide addition to maintain the strength of the bath. Some adjustment of the salt concentration in this bath will probably be necessary but the preliminary tests indicate that it will stabilize at about 10%.

The remaining steps in the automated beamhouse are mechanical and are shown schematically in Figure 3.

After being transferred from the bar to a clamp on a second conveyor the hide moves from the last bath to a point where it is halfway into an open mechanical unhairing machine. Half of the hide is unhaired and then moved in the same manner halfway into a fleshing machine. After the hide is fleshed, it is flipped over end for end and the process repeated so the remaining half of the hide is unhaired and fleshed. In the construction of this pilot plant we did not include both sets of unhairing and fleshing machines. We were only concerned with demonstrating the principle. In our actual operation we bring the hide back to the same machines to unhair and flesh the second half.

The hide is then moved into the splitter feeding mechanism and split to the desired weight. The top grain and split are then ready for sorting and further conventional processing.

To summarize the status of our research on the mechanized beamhouse, the automated splitting mechanism has not been in full operation, however, it does not seem to present any insurmountable problems and we are continuing to improve it. The conveyer mechanism has been constructed and is operable although it may also be subject to further modification in order to improve it. The chemical process has been tested in the pilot plant. The hair burn proceded well and though we expect some modifications may be made, the principle appears sound.

The automated beamhouse provides several advantages over conventional processing. It reduces the labor required up to unhairing, and doing so, eliminates some of the more difficult duties in the tannery. The hide being only slightly swollen permits the splitting to be more accurate than you would expect in lime splitting. This in turn should reduce shaving and buffing wastes. Once unhaired, the top grain and bottom splits can be sorted before

chrome addition and clear decisions can be made on the most profitable way to further process them. Further processing of either split is more rapid and uniform because the hide is thinner and chemicals can penetrate more quickly and uniformly. A further benefit is that only those portions of the hides which will become leather will be chrome-tanned, reducing further chrome containing solid wastes. Lastly, while the final water balance is not completely known, it appears the process will reduce water usage over conventional unhairing.

Computer Model

The second part of this report is on the development of a computer model of the conversion of raw hides to blue crust leather. This work was developed jointly by our Laboratory and the Oklahoma State University. The modeling of chemical processes is not a new concept. It is done most frequently with simple processes where the physical and chemical properties of the components of the system are well understood. For example, in the petroleum industry modeling of the fractionation of petroleum products by distillation has been done successfully. If the components of the crude fraction to be separated are known, and the efficiency of the distillation apparatus is well known, distillation can be predicted from a computer model of the process. If, for example, a company were attempting to maximize the yield of home heating oil, the model can be used to predict the most efficient fractionation procedure. The same program can be used to guide the operation of the distillation to maximize the production of gasoline.

Attempting to model a tannery operation, which consists of physical and chemical processes which are and not as thoroughly known or understood is a formidable objective. Realistically, it may never be accomplished fully, although some steps in the process could potentially be completely modeled. One example might be the relationship between a physical property such as

tensile strength or elongation with the amount of chrome offered or taken up during tanning. This relationship would probably have to be obtained empirically through the results of a large number of experiments. This remains a long range objective of this modeling project and experimentation will continue with this in mind.

When the model was in the initial planning stages it was decided to approach it first on a materials balance basis. It was started by characterizing various components of the hide and following them throughout the tanning process. There are twenty five components allowed in the current program but that number can be expanded (Figure 4). These include the number of hides, area per hide, dry weight, hair, dirt, water, salt, calcium, chromium. As each process chemical is added, it is either incorporated into the hide or it ends up in the effluent. Similarly, some components of the hide stay with the hide and others end up in effluent or in by-product streams. Whatever happens, all of the chemicals and hide components that go into the process must equal the total chemicals and hide components leaving the process. To accurately build this into the program, you must have some information about the partitioning of these chemicals between the hide and the treatment solutions. For example, the amount of calcium taken up by the hides in your unhairing process as well as the amount remaining after the bate. These factors are put into the model as constants. Thereafter, when you run the model the calcium content of the hide and of the effluent is calculated based on that constant.

While still discussing this aspect of the model, it became clear that other economic information in addition to the cost of chemicals could be incorporated into the model. For example, each step in wet processing,

whether it involves moving a hide from a rail car into storage or the unhairing of the hide, could be clearly defined. Each step could have associated with it a certain amount of labor, chemicals, overhead, tannery space requirements and the specific piece or pieces of equipment needed to perform the task. The machine itself could be identified and values obtained for annual depreciation, cost of repair, replacement value, estimated machine life and capacity of operation in terms of pounds of hide processed per day. Overhead could be broken down into taxes, office equipment and personnel, land costs and building depreciation. In short, all of the costs of producing split and shaved wet blue stock from raw hides could be accounted for in this model.

In addition, an energy cost for the overall process has been incorporated into the model. The temperature of incoming process water for the tannery is one of the default valves in the model. The amount of energy required to bring the treatment solutions to the temperature specified in each individual step is automatically calculated. A energy cost is then established based on the fuel cost and the amount used to heat the process water.

It should be emphasized that a good accounting department can and probably is already providing this information. With a little more effort your information can probably be broken down into the cost of each individual step in the process. The advantage of this model is that once the necessary information is incorporated into the program and the program is customized for your tannery, it can be used rapidly to analyze the impact of a variety of factors on the economics of your tannery operation. In addition, it is a reproducible means of comparing one set of circumstances with another. If at two different times, for example 6 months apart, it is necessary to analyze the impact of some economic change on your tannery you may get the answers based on somewhat different approaches to the problem. This is because each time a problem is analyzed, there are many ways to find a solution. If for example depreciation was not handled the same way each time the analysis is

made, the final answers might not be comparable. The use of the model by virtue of its fixed structure provides comparisons based on treating the same information in the same way each time. We cannot guarantee that the answers are any better, of course. As in any computer based operation, the results will be no more accurate than the information on which it is based.

The Basic Model

Proceeding from this background we will describe how a tanner would customize the model to fit his own tannery and then demonstrate the type of information which can be generated by the model.

Thirty four separate modules have been developed which describe as many different operations which can take place during the processing of hides into blue stock. Each module has associated with it an input hide stream and an output hide stream. These streams have associated with them the 25 characteristics described earlier. The simplest module describes a mechanical step much as FORK which describes the movement of hides by forklift from one area of the tannery to another (Figure 5).

In this step there are no changes in the hide characteristics. There is, nevertheless, a cost associated with the operation which includes labor, overhead, depreciation and the other factors described earlier.

An example, Figure 6, of a more complicated module would be LIME. Associated with this module are the input and output streams for the hides. The program includes the changes in the hide which will take place in that process step, in this case with reliming. In addition, this module has another input stream which is referred to as a demand stream. This stream also can carry the same 25 components listed in the hide streams. In this particular case, it contains calcium and water. There is an output stream with the same components. The output will contain everything which enters the module in either a demand stream or the hide itself which does not leave with the hide. This means there is a materials balance in ea

material coming into the modules is equal to the total material coming out.
Figure 7 illustrates the input and output streams associated with LIME.
The number and area of hides did not change but the calcium and moisture
content did. This is reflected in the output hide stream where the moisture
content of the hide has increased. The second output stream, which is of
course the effluent for this step, now contains the salt removed from the hide
in addition to calcium.

The tanning process module, Figure 8, is a little more complicated.
In this case, there are three demand streams and an effluent output stream in
addition to the hide stream. Other modules vary in complexity somewhere
between these last two examples. It is possible to have only a hide stream
coming into the module and a hide stream and another output stream going out
as in the case of a wringing or trimming operation.

Although specific modules have been created for each process step, it may not
be necessary to create a new one even if you have a unique step in your
process. Many of these modules are general enough that they could be readily
adapted to describe other similar process steps.

In every case, the hide output stream goes to the next process step where it
becomes the new hide input stream. The output streams other than the hides may
go to several different destinations. They may go to an effluent stream,
singularly or in combination with other effluent streams and generally from
there go to a waste treatment module. These modules calculate the cost of
treatment based on total stream BOD content. Other output streams may go to a
recycle module which can provide input streams for other modules. Another
possible destination for an output stream is to a by-product module which
generates a cost recovery factor if one exists. In all cases, the output
stream must have a specific destination for the program to operate.

In modeling one's own tanner, a tannery must select a series of modules which
accurately describes his operation. The description must be complete and

computer program as it now is structured, if the modules are properly put together the program can be run and information generated. This is because the program already has built into it a default value for every piece of information needed to run the model. These are generalized figures which the program uses if they are not specified. This is useful to insure that the initial model is properly constructed. The resulting information is, however, not very useful because the default values are too general.

This then is the next step in the process. Each specific piece of information called for must be inserted in the model. For example, for a Mercier splitter then the SPLIT module will need to specify its current value, replacement cost, capacity and so on. In addition, the module must specify the changes in hide characteristics which are associated with a specific process. For example, what amount of calcium is taken up by the hide during reliming and how much is removed during the bate? This information is needed for the program to generate chemical cost information. In actual practice you will not need an extensively equipped analytical laboratory to set up these balances. You can satisfactorily set up this balance based on your chemical usage and the composition of your effluent streams. The labor associated with the use of each machine including operators, laborers, and supervisory personnel is required to calculate labor costs. It is perfectly permissable to use a fraction of a person for a particular operation. When calculating labor costs the model only rounds off the total labor required to a whole unit. Lastly, you have to insert the general information which is used by many of the modules. Most of this is information which is frequently changing such as chemical prices, taxes, overhead to be written off based on square foot of space allocated in the tannery, electrical and water costs and a variety of others. A users manual prepared by Dr. Trapp describes the necessary information in detail. Once you have all of this data in place you are ready to run the program.

The full output of the program consists of eleven separate tables. Each table consists of six subtotals and a grand total. The subtotals are generated within the overall process over a specific series of steps which you specify. The only restriction is you cannot overlap steps. Figure 9 shows the sequence of modules for a specific tannery which participated in the development of this model.

It illustrates that the process is broken down into six sections for summary purposes. The first section consists of modules involving movement of the stock from a loading area, weighing it, moving it to storage and then into a sorting operation. The second section consists of modules which are used to move the hides into the trimming area after which they are fleshed, washed and conveyed to the next operation. This subtotal also includes the by-product module for rendering the trimmings. Using a short perhaps two minute procedure you could include the sorting operation in the second subtotal instead of the first. The additional sections are III, beaming, IV tanning, V wring, side and sort, and waste treatment.

The first summary table which the model produces itemizes the costs allocated to each of the six sections as well as the total for capital cost of manufacturing space, office space, furniture, land, waste management land and a total for land and buildings. The second summary table identifies the actual number of pieces of equipment required to run the number of hides specified using the capacities you incorporated into the program. This summary will add a new machine for a process if capacity is exceeded by a single hide. The next table contains the costs of the equipment specified in the second table.

Tables four and five are concerned with labor. Labor is listed in hours per year and is specified as department supervisor, foreman, machine operator or laborer. Other divisions are possible. The cost of that labor per year is included in table five.

Table six lists the overhead costs broken down into variable and fixed costs. The variable costs relate to production and increases or decreases with production. Electricity, water repair and depreciation of machinery are some examples. Fixed costs include taxes, insurance, building depreciation and others that do not change with variations in production.

The seventh and eighth tables summarize chemical usage in pounds per year and the cost associated with this usage.

The capital summary is the ninth table and this prints out the capital costs for building and land, waste treatment facilities, land for waste treatment and total equipment. The last two summaries are the most interesting form the standpoint of comparing processes. They are the Operating Costs Summary, Table 1, and the Net Blue Hide Processing Costs, Table 2.

The Operating Costs Summary is broken down into hourly and salaried labor, fixed and variable overhead, and chemical costs. Using the tannery process which was shown earlier and using labor rates, chemical costs and all other default figures at 1980 values the operating costs per hide were calculated to be $4.71.

The cost per square foot of blue stock produced was $.13.

Net blue hide processing costs were calculated by adding the overall cost of processing plus the cost of hides and subtracting a credit for by-product recovery for trimmings and fleshings. The net processing cost per square foot for this particular process was $1.07.

Now that the model is complete it can be used to make comparisons with alternate processes. Changing certain variables in the program will allow you to simulate new conditions which might affect the operation and profitability of your tannery. The following examples should demonstrate how the program can be used.

Model of 10% Inflation

A current relevant problem for tanners around the world is inflation. How does

a ten percent inflation rate affect the cost of processing hides to the blue? Over a period of time, if inflation continues at a 10% rate, all production costs would increase by 10%. Production costs in the short run, however, will not increase by that rate. Many costs are fixed due to previous capital investments, or fixed loan rates on previously borrowed money. To make decisions on increasing the cost of your product you need to know the impact of increased costs of non-durable items such as chemicals, labor, interest on new money, utilities and other overhead costs. To answer this question, the prices listed for these items in the program were increased by 10% and the model rerun with all other prices and parameters remaining the same as the base model. The results are shown in Table 3.

Operating costs increased by 8.4%. A full 10% rise did not occur because depreciation is included in operating costs and is not affected by inflation. Sections of the tannery with a high capital investment relative to labor and variable input costs experienced smaller percentage increases. In this example raw hide costs and by-product returns are held constant. This is because of the volatility of these prices which are determined by factors which seem to be independent of inflation.

The Net Blue Hide Processing Costs reflect only a 1.01% (Table 4) increase in short run costs due to a 10% rise in inflation. Therefore, short term inflation could be covered by only a small increase in product cost. Continued increases in inflation over a long period of time without commensurate product price increases would result in inadequate capital accumulation to replace existing equipment. Therefore, in the long run the tanners assets would be depleted.

Another difficult decision which must occasionally be made by a tanner is whether or not to cut back production below full capacity. If a slowdown is expected to be temporary, it may be desirable not to lay off employees. The question then becomes, what effect does such a slowdown have on production

The process parameters of the base model were adjusted to simulate production at 80% of capacity with a full labor force. This is done by reducing the number of hides from 2000 to 1600 and allocating each machine to 80% of capacity. This latter change is necessary because the program will only allocate the machines necessary to run the specified production. If you did not reduce the capacity of the equipment, the program would generate erroneous costs based on fewer pieces of equipment.

A 20% reduction generates an overall 10.8% reduction in operating cost (Table 5). The largest drop, of about 15%, occurs in the bate/pickle/tan operation where the labor input is low relative to other costs such as chemicals. Those areas with relatively high labor requirements as expected showed a much smaller reduction in operating costs. In the wash/trim/flesh area only a 34% reduction occurred.

The net cost seen in Table 6 shows that while processing cost per hide increases by 10% the overall cost increase is only 1.42%. How this increased cost should be handled would have to be weighed against the other alternative ways to deal with the problem which caused the reduced production in the first place.

Model of Economy of Scale

The model can be useful in making a decision to either expand current facilities or to cut back production on a more permanent basis. The decision to be made is whether to make additional capital expenditures or to sell existing capital. Using this program, it becomes evident that economy of scale is not a straight line function. That is, the cost of production per hide does not decrease in a straight line as production increases. It turns out that the economies of scale, in fact, reach certain plateaus where unit production costs do not decrease with increasing numbers of hides processed. Again, using the model already constructed as an example, a series of

costs per hide and capital investment required were graphed for each plant
size from 1000 to 3500 hides per day at 100 hide intervals (Figure 10).
Substantial economies were achieved up to a capacity of about 2000 hides a
day. At this point, the economies stabilize and do not come down again until
capacity reaches 3000 hides. The reason is that certain machinery in the
model reach their capacity in this range. This is true of the wringer, washer
and siding machines. Up to the point where the capacities of these units are
exceeded, the only unit required to increase capacity are hide processors.
One new hide processor is needed for each additional 200 to 300 units of
expansion. The capital cost of the other units continues to be spread over
increasing production levels up to 2000 hides a day. At this point an
additional set of these units must be purchased and economies are not seen
again until this cost is again spread over a large number of units. This
happens at about 3000 hides a day. The cost per hide processed again decreases
with increasing production until the capacity of the second set is reached.
If the graph were extended to 6000 hides per day, another plateau would appear
at 4500 to 5500 hides a day.

The conclusion drawn from this use of the model is that if the other
modifications cannot be made such as additional shifts or altered sequences of
processing, the most efficient size for the tannery specified in the model is
2100 or 4500 hides a day. Your own tannery would likely have different
capacities for efficient operation. However, it should be kept in mind that
the major economies of scale were achieved at 2100 hides. Further economies
are smaller and other considerations such as procurement costs, quality
control, and/or marketing might be more important than the total savings.

Model of Process Alternative

The last example is an evaluation of a change in processing methods. You can,

for example, trim before or after unhairing, eliminate or add a recycle process or change from drums to hide processors. Each change can be modeled and the effect evaluated and compared to the original system.

Suppose that you were to consider purchasing fleshed hides rather than prefleshed hides. This allows you to eliminate the fleshing process but it also eliminates revenues from the rendered fleshings. To perform this analysis hide costs were left the same. The difference in net processing costs can be interpreted as a premium which could be paid for prefleshed hides. Savings from eliminating the fleshing operation come from two areas. Capital cost in the wash/flesh/trim section is reduced because the two fleshing machines and accessory pallets are no longer needed. In an existing plant the reduced space savings would not be realized unless another operation was able to expand into that area.

Table 7 shows that the operating costs are reduced by 5.7% primarily because the machine operators are no longer needed. In addition, there are other reductions in overhead such as utilities, insurance and depreciation.

The net processing costs for the fleshed hide system shows a 0.2% decrease in the net costs per hide. The actual savings is 25.0 cents per hide but this is largely offset by a loss of income of 19.0 cents per hide from rendering. Thus, the conclusion is that for this particular tannery there is little advantage in making the change. If, however, the credit for by-products was not available a savings of 25 cents per hide might be significant.

There are numerous other ways this model could be used. These four examples only represent examples of questions tanners need to ask at one time or another. Each of you could think of numerous additional ways to use the model. The real advantage of the model is the speed with which comparisons can be made. Consider the difficulty in evaluating the cost of processing hides at 25 different levels of production without such a model.

Conclusion

To summarize, a computer model of a tannery operating through to split and shaved blue stock has been developed. It can be used for rapid economic and financial analysis of alternative wet processing systems as well as changes in production due to inflation or other economic factors. The numbers and costs presented here are only meant to be illustrative of the capabilities of the model. In actual use the model would have to be carefully customized to model a specific tannery.

The cost per analysis is minimal. Each alternative considered would probably cost less than five dollars and turn around time on a high speed terminal printer would probably be only minutes. You could operate the program on your own computer or rent space and time on a commercial operation.
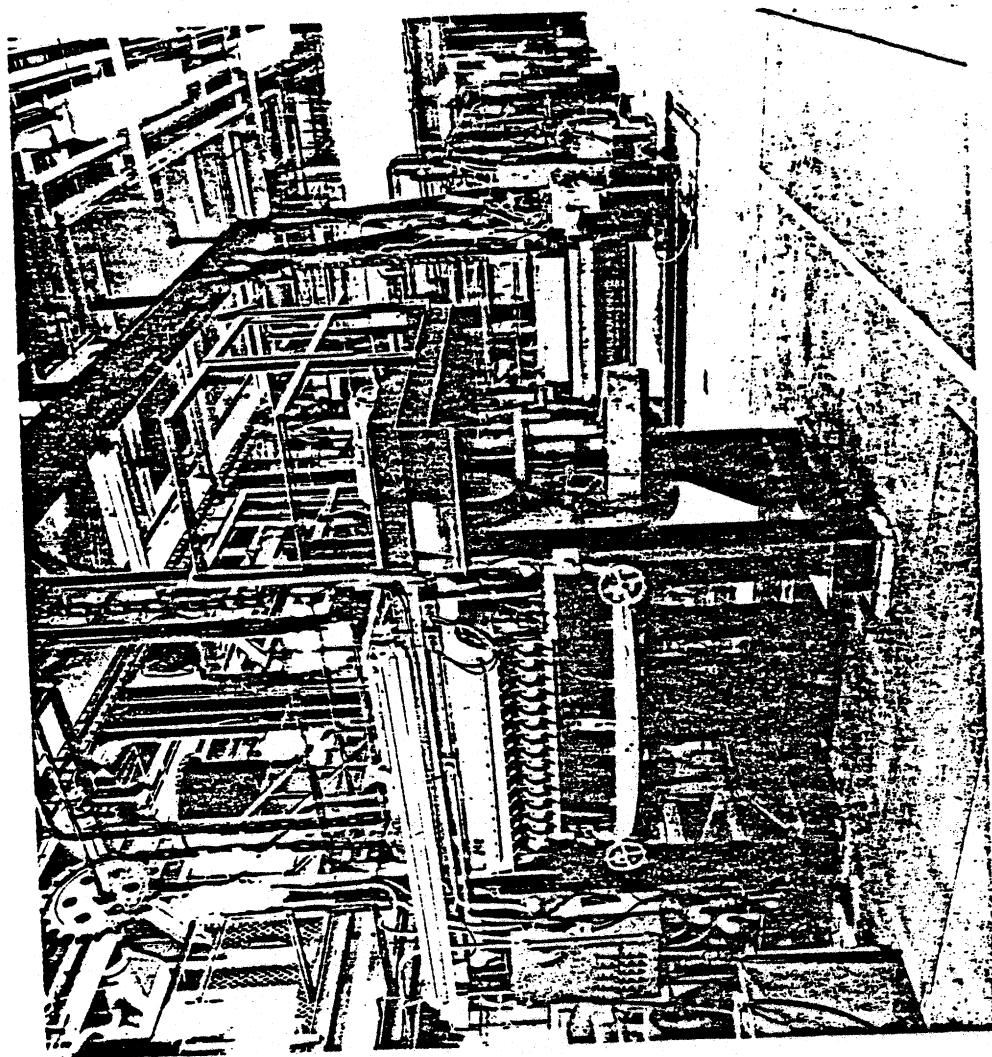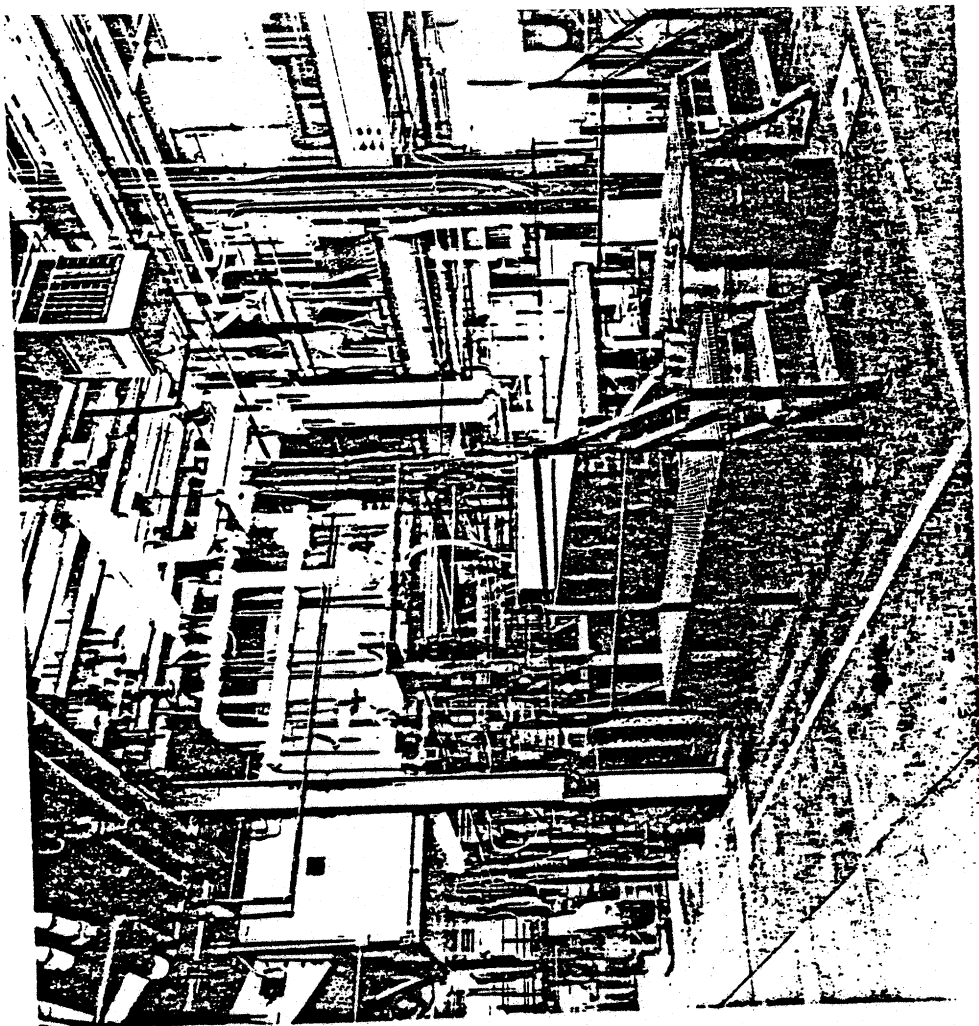
The program is not meant to replace the functions of an accounting department. On the contrary, it should enhance their capabilities. It certainly could not be implemented without them.

Finally, as in any computer based system, the value of the model is no greater than the quality of the information put into it. We have held one workshop in the United States and presented the actual programming procedures to put the model into practical use. It was well received and as a result we believe this model can be an important tool for the management of a tannery. We are planning to increase the scope of the model beyond wet processing to finished leather, to further increase its value to the tanning industry.

Legends for Figures and Tables

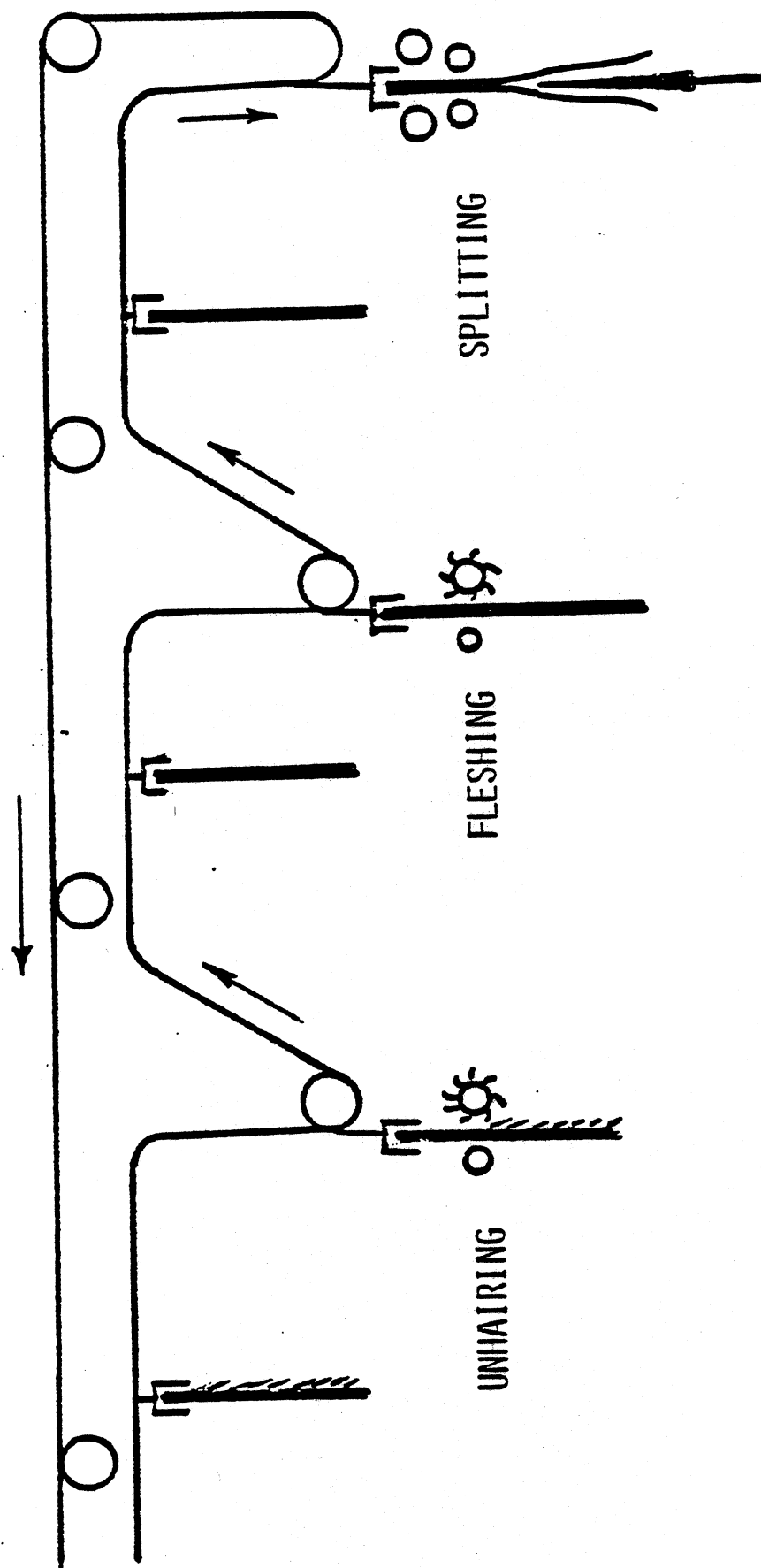Figure 1   Photograph of automated beamhouse pilot plant at the Eastern Regional Research Center. On the left is the view from the automated splitter. On the right is the view from the conveyer which inputs the hides into the chemical baths.

Figure 2   Schematic of chemical process section of automated beamhouse

Figure 3   Schematic of mechanical process section of automated beamhouse

Figure 4   Representative hide stream components used in computer model

Figure 5   Module representing movement of hides by forklift

Figure 6   Module representing lining of hides

Figure 7   Module representing lime step with example of materials balance of hide components

Figure 8   Module representing tanning of hides

Figure 9   Schematic of hypothetical tanning operation

Figure 10   Economy of scale for base model showing total investment and cost of treatment per hide as the size of the tanning changes from 1000 to 4000 hides per day.

AUTOMATED BEAMHOUSE (1)

Figure 2

UNHAIRING   FLESHING   SPLITTING

AUTOMATED BEAMHOUSE (2)

Figure 3

STREAM CHARACTERISTICS

1.	# OF HIDES	HIDES/DAY
2.	AREA	FT2/HIDE
3.	DRY WEIGHT	LB/HIDE
4.	HAIR	LB/HIDE
5.	DIRT	LB/HIDE
6.	WATER	LB/HIDE
7.	SALT	LB/HIDE
8.	CALCIUM	LB/HIDE
9.	CHROMIUM	LB/HIDE
.		LB/HIDE
.	(VARIABLE)	LB/HIDE
.		LB/HIDE
25.		LB/HIDE

HIDE IN ———— FORK ———— HIDE OUT

DEMAND IN

HIDE IN

LIME

HIDE OUT

EFFLUENT OUT

Figure 6

DEMAND IN ─────────┐
                   │
HIDE IN ──────────┤ LIME ├─────── HIDE OUT
                   │
                   └─────── EFFLUENT OUT

		HIDE	DEMAND	HIDE	EFFLUENT
1.	# OF HIDES	2000	-	2000	-
2.	AREA	38.0	-	38.0	-
3.	DRY WEIGHT	19.9	-	19.7	400
4.	HAIR	0	-	0	0
5.	DIRT	0.03	-	0.01	40
6.	WATER	32.0	208,000	42.6	186,800
7.	SALT	0.99	-	0.19	1,600
8.	CALCIUM	0.14	2,080	0.25	1,860
9.	CHROMIUM	0	-	0	-
.					
.					
.	(VARIABLE)				
25.					

DEMAND #1 IN

DEMAND #2 IN

DEMAND #3 IN

HIDE IN

TAN

HIDE OUT

EFFLUENT OUT
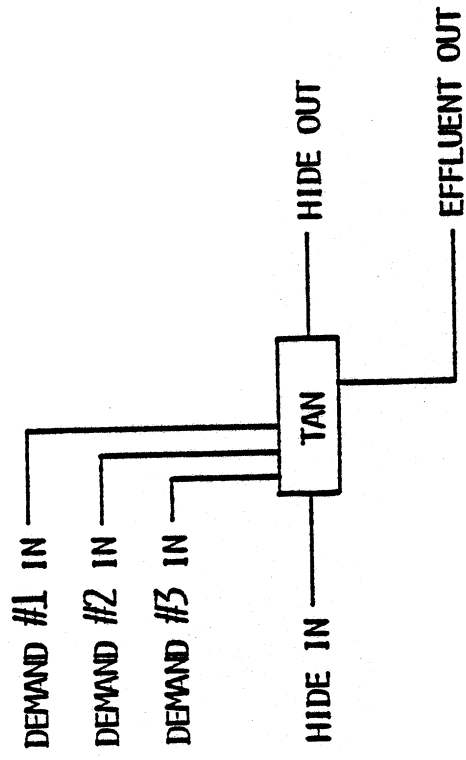
Figure 8

MODELE DE TANNERIE

I

II

III

IV

V

VI

INPT — FORK — SCAL — STOR — SORT

CONV — WASH — FLSH — TRIM
REND   REND

FORK — UNHR — FORK
SULF

SCAL — TAN
CROM

SORT — SIDE — WRNG — FORK
ADDR

EVAP — AIR 2 — AIR 1 — EQUI
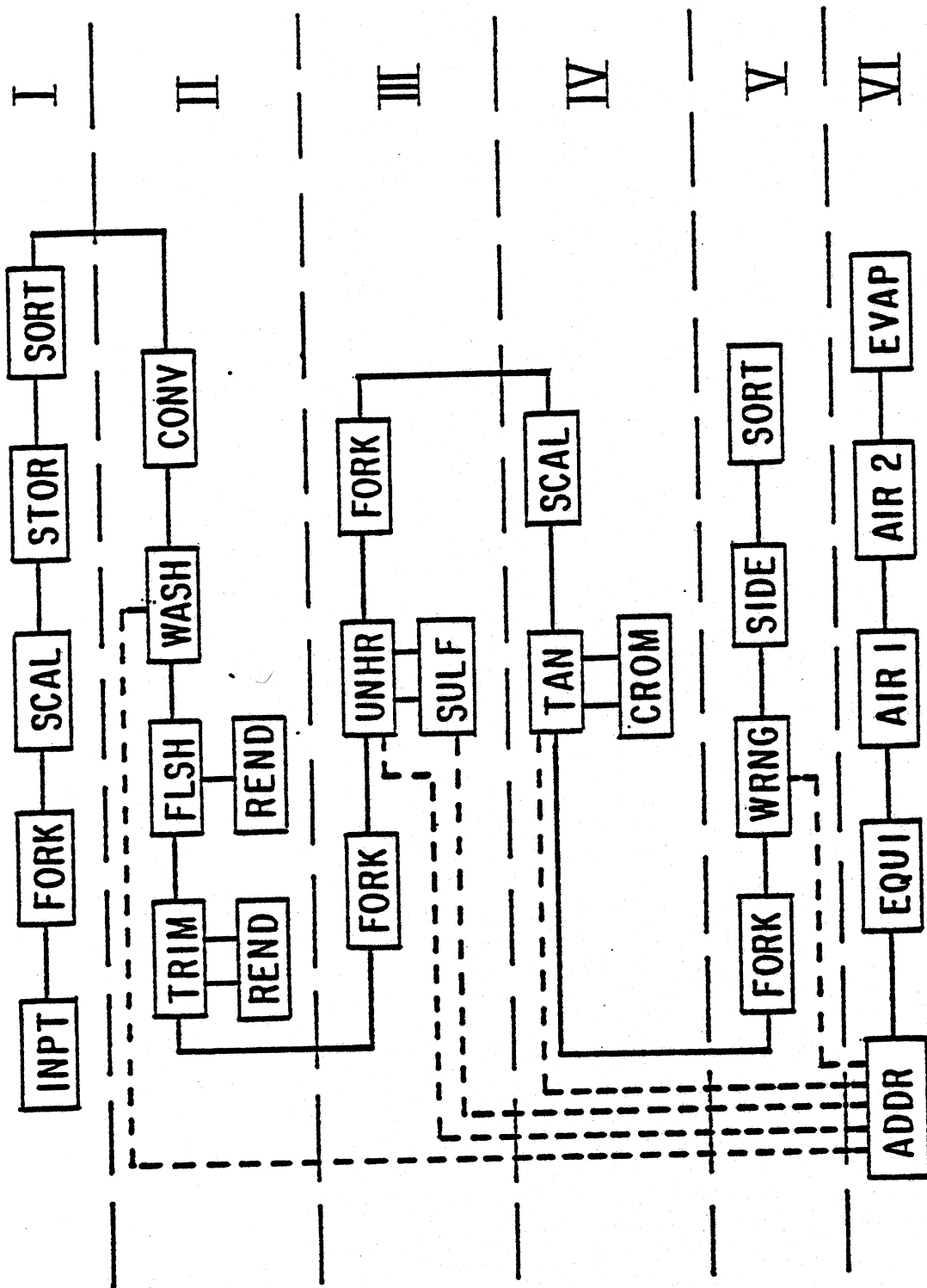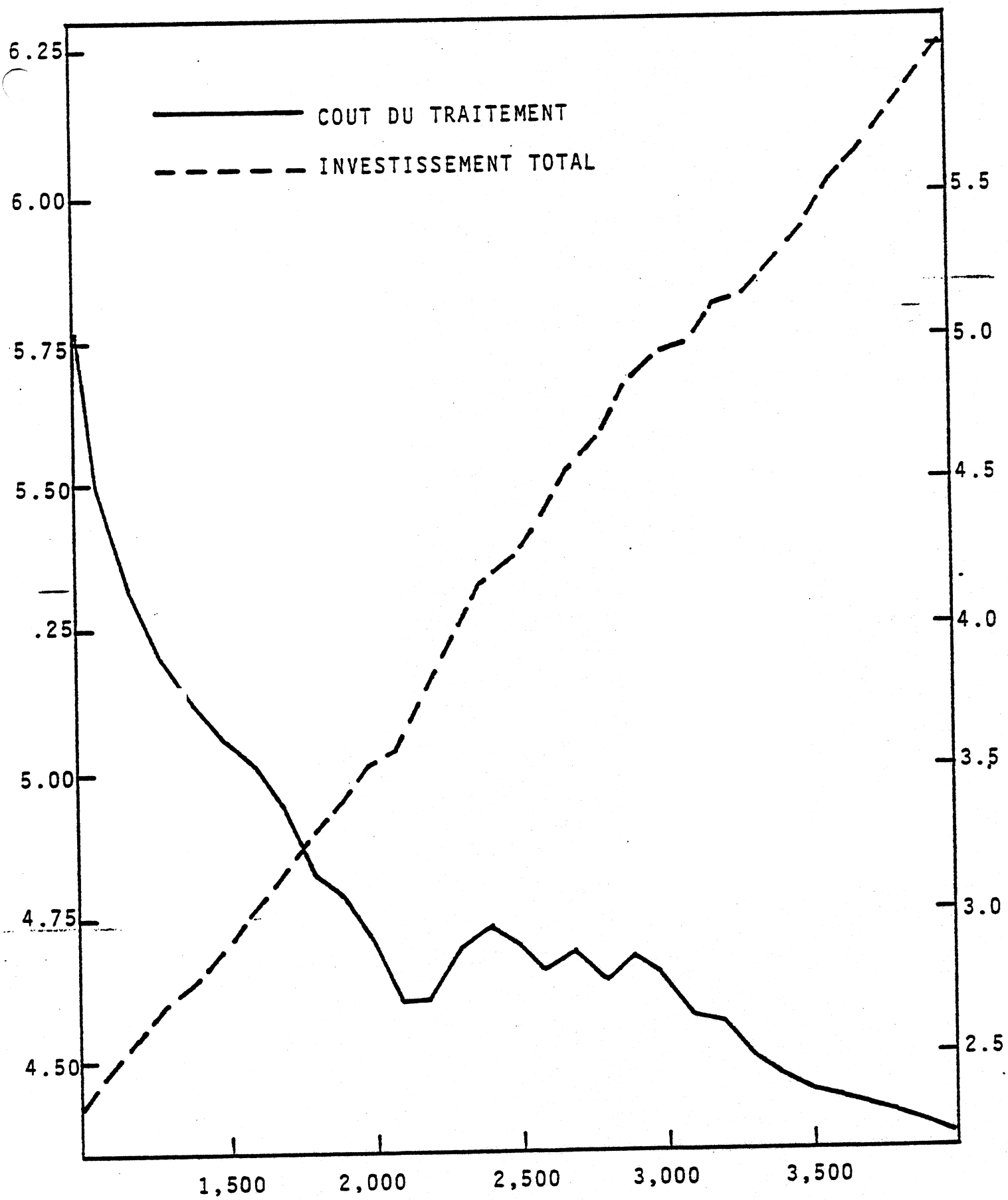
COUT OPERATIONNEL ANNUEL POUR LE MODELE DE BASE

	I	II	III	IV	V	VI	TOTAL
MAIN D'OEUVRE PERMANENTE	6,588	16,836	51,714	49,032	7,320	0	131,490
MAIN D'OEUVRE HORAIRE	23,912	121,024	68,320	68,320	54,656	69,278	405,510
FRAIS GENERAUX FIXES	27,189	34,309	142,385	128,375	23,496	5,213	360,967
FRAIS GENERAUX VARIABLES	19,676	62,641	167,915	158,688	82,666	24,359	515,945
PRODUITS CHEMIQUES	0	0	169,992	716,189	0	0	886,181
COUT OPERATIONNEL TOTAL	77,365	234,810	600,326	1,120,604	168,138	98,850	2,300,093

COUT NET ANNUEL DES PEAUX BLEUES POUR MODELE DE BASE

NATURE DES COUTS	COUT ANNUEL	COUT PAR PEAU	COUT PAR PIED CARRE
COUT OPERATIONNEL	2,300,093	4.71	.1309
COUT NET PAR PRODUIT	- 132,807	- .27	-.0076
COUT DES PEAU BRUTES	16,799,396	34.43	.9462
COUT NET DU TREATMENT	18,966,682	38.87	1.07

Table 2

COUT OPERATIONNEL ANNUEL - 10% INFLATION

	I	II	III	IV	V	VI	TOTAL
MAIN D'OEUVRE PERMANENTE	7,247	18,259	56,885	53,935	8,052	0	144,639
MAIN D'OEUVRE HORAIRE	26,294	132,931	74,957	75,152	60,122	76,017	445,433
FRAIS GENERAUX FIXES	29,595	37,100	154,960	139,604	25,486	5,714	393,459
FRAIS GENERAUX VARIABLES	20,201	65,883	172,773	163,425	86,328	24,511	532,940
PRODUITS CHEMIQUES	0	0	186,981	789,740	0	0	976,721
COUT OPERATIONNEL TOTAL	83,116	254,434	646,556	1,221,856	179,988	106,242	2,292,192
VARIATION PAR RAPPORT AU MODELE DE BASE	+ 7.4 %	+ 8.4 %	+ 7.7 %	+ 9.0 %	+ 7.0 %	+ 7.5 %	+ 8.4 %

COUT NET ANNUEL DES PEAUX POUR 10% INFLATION

NATURE DES COUTS	COUT ANNUEL	COUT PAR PEAU	COUT PAR PIED CARRE	VARIATION PAR RAPPORT AU MODELE DE BASE
COUT OPERATIONNEL	2,492,192	5.11	.1419	+ 8.35 %
COUT NET PAR PRODUIT	- 132,807	- .27	-.0076	0
COUT DES PEAU BRUTES	16,799,396	34.43	.9562	0
COUT NET DU TREATMENT	19,158,781	39.26	1.0905	+ 1.01 %

COUT OPERATIONNEL ANNUEL - 80% CAPACITE

	I	II	III	IV	V	VI	TOTAL
MAIN D'OEUVRE PERMANENTE	6,588	16,836	51,714	49,032	7,320	0	131,409
MAIN D'OEUVRE HORAIRE	23,912	121,024	68,320	68,320	54,656	69,278	405,510
FRAIS GENERAUX FIXES	27,189	34,309	142,385	128,375	23,496	5,213	360,967
FRAIS GENERAUX VARIABLES	17,471	54,970	152,726	132,276	68,971	20,544	447,958
PRODUITS CHEMIQUES	0	0	135,994	572,961	0	0	708,955
COUT OPERATIONNEL TOTAL	75,160	227,139	551,139	951,964	154,443	95,035	2,054,880
VARIATION PAR RAPPORT AU MODELE DE BASE	- 2.9%	-3.4%	- 8.2%	-15.0%	- 8.1%	- 3.9%	-10.7%

COUT NET ANNUEL DES PEAUX BLEUES POUR 80% CAPACITE

NATURE DES COUTS	COUT ANNUEL	COUT PAR PEAU	COUT PAR PIED CARRE	VARIATION PAR RAPPORT AU MODELE DE BASE
COUT OPERATIONNEL	2,054,880	5.26	.1462	+ 10.8%
COUT NET PAR PRODUIT	- 106,246	- .27	-.0076	.0
COUT DES PEAU BRUTES	13,439,512	34.42	.9562	.0
COUT NET DU TREATMENT	15,388,146	39.41	1.0948	+ 1.42

COUT NET ANNUEL DES PEAUX BLEUES

NATURE DES COUTS	COUT ANNUEL	COUT PAR PEAU	COUT PAR PIED CARRE	VARIATION PAR RAPPORT AU MODELE DE BASE
COUT OPERATIONNEL	2,169.244	4.46	.1235	- 5.7 %
COUT NET PAR PRODUIT	- 37,174	- 0.08	- .0076	- 72.0 %
COUT DES PEAU BRUTES	16,799,392	34.43	.9562	0
COUT NET DU TREATMENT	18,931,462	38.81	1.0776	- 0.2 %